

Phosim Sensor Effect Validation

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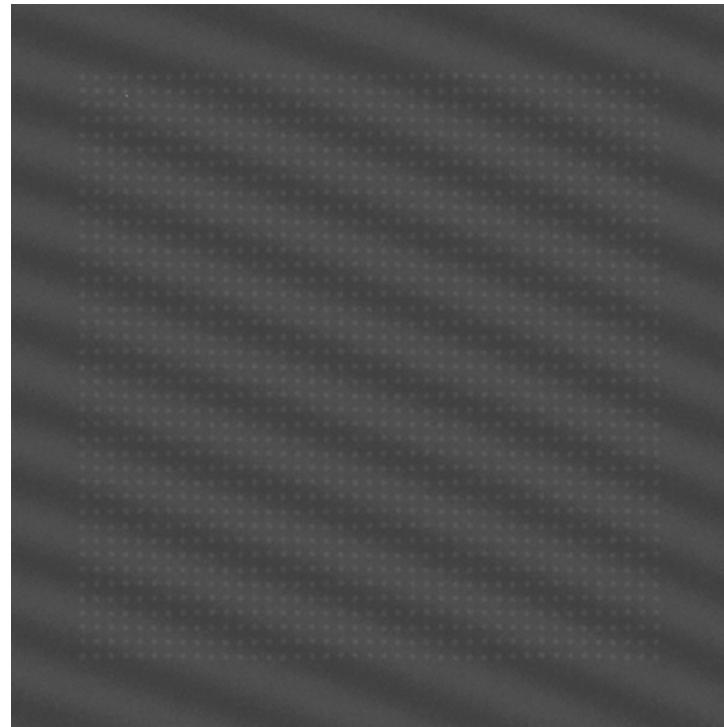
November 4, 2014

Presentation Overview

- Tree ring impact on point sources
 - Tree Rings in Phosim
 - Tree Ring Impact on Flats vs Point Sources
 - Edge Effect
 - Raft Orientation
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- Goal: validate Phosim for TR, edge roll-off and other sensor effects

Phosim

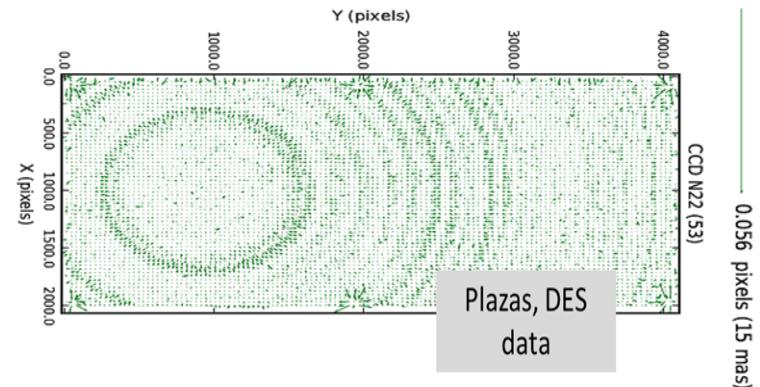
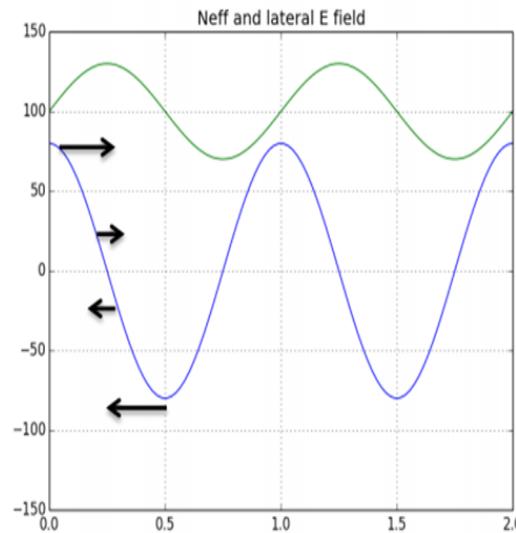
- Simulations done without Background, Atmosphere, Jitter, or Optical imperfections.
- Field of identical sources with no object overlap (Both regular grids and random fields of non-overlapping stars).
- Find stars, measure centroids and ellipticity parameters with SourceExtractor.
- Compare centroid positions to a reference simulation with identical physics settings but without doping variations.



Overlaid tree rings (visible in background) and stars

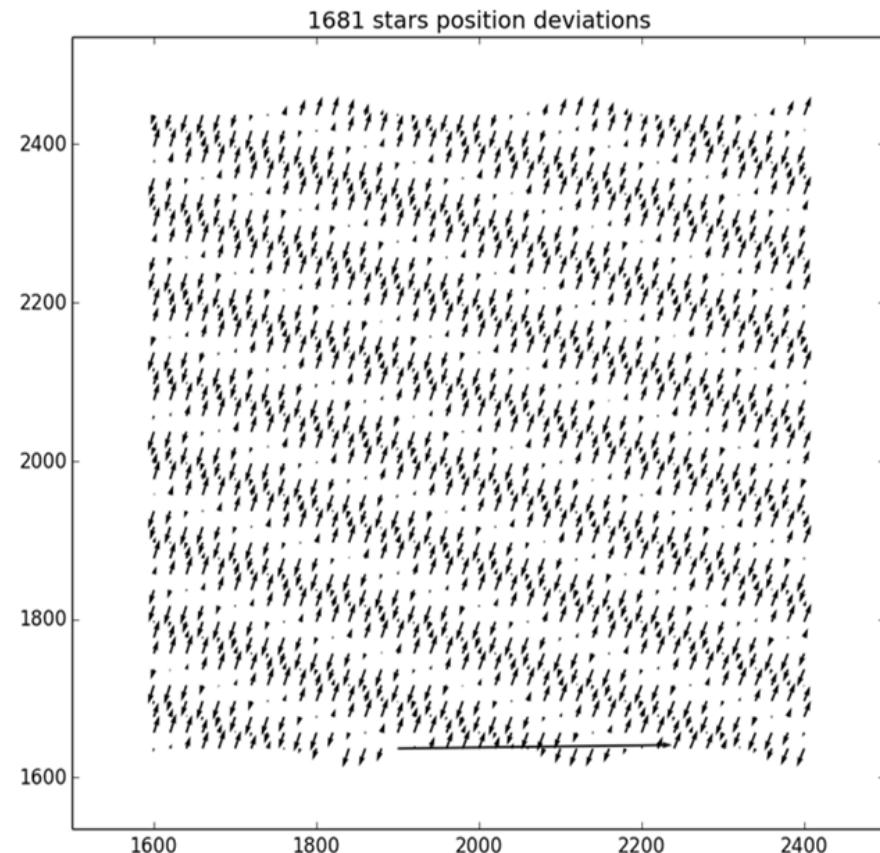
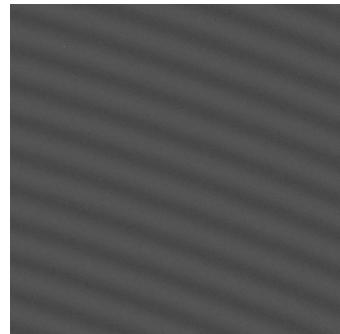
Phosim Tree Rings vs Real Effect

- Tree rings in Phosim described by 4 parameters, the dopant variation amplitude, period, and the coordinates of the origin
- Goal of the study: validate Phosim for TR



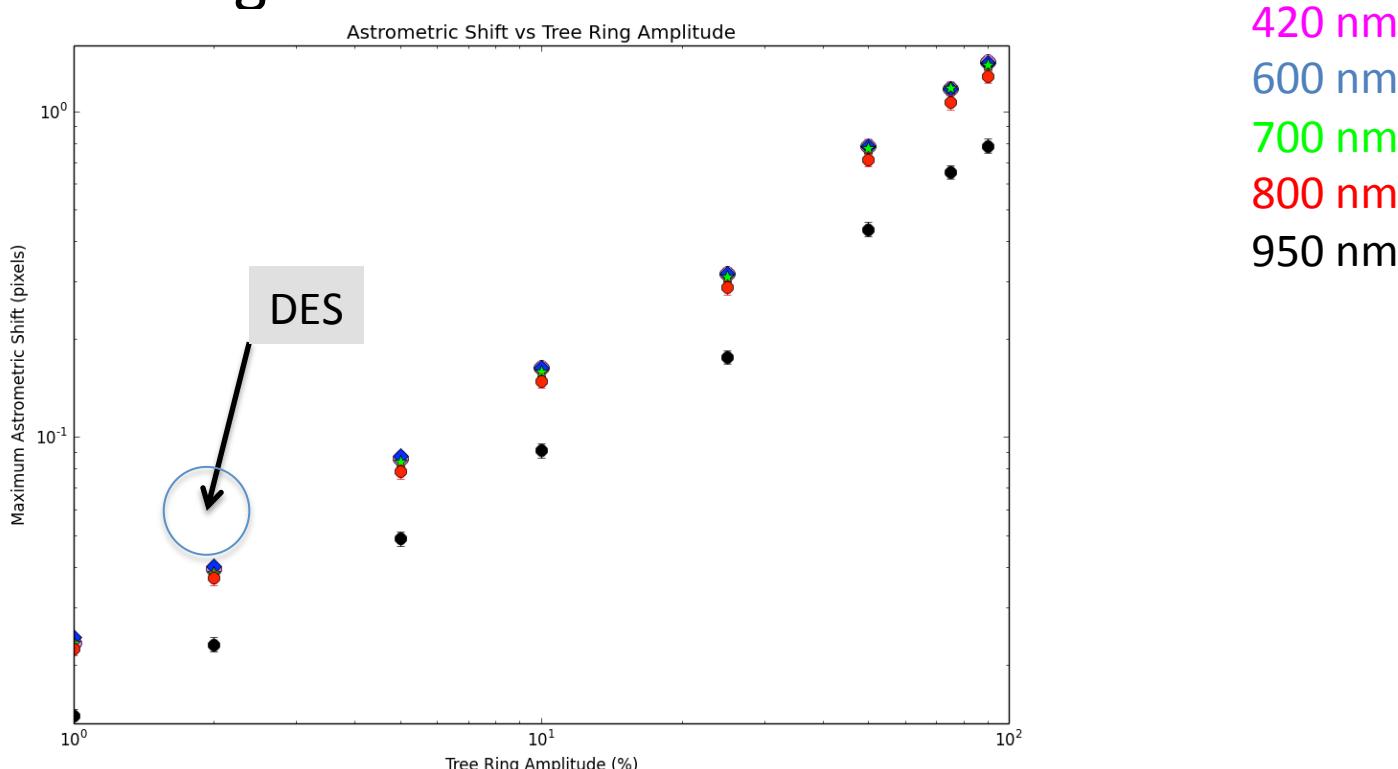
Impacts of Tree Rings

- Astrometric shift along radial direction; Depends on color/R
- Ellipticity/Orientation & Object Size Oscillations
- Flat Field Intensity Variations



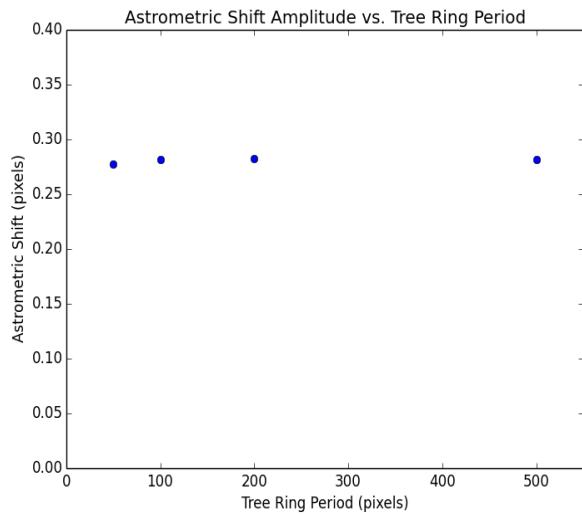
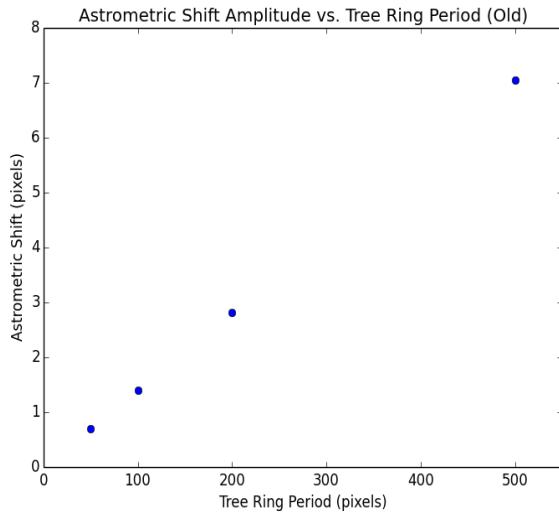
Astrometric shifts vs tree ring amplitude and color

- DES data corresponds to a few % doping variation (Phosim default is 1%)
- TR in the latest LSST prototypes are small but absence in final sensors is not guaranteed



IR is shifted less as expected

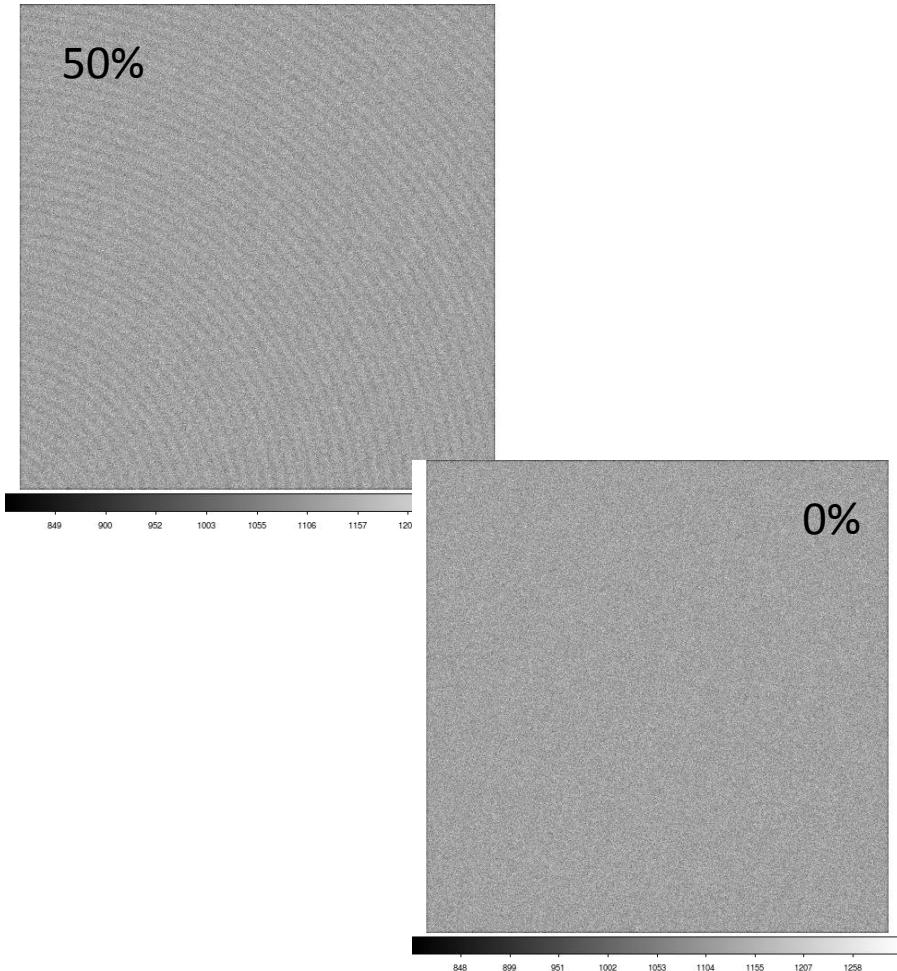
Tree Ring Period vs Shift Amplitude



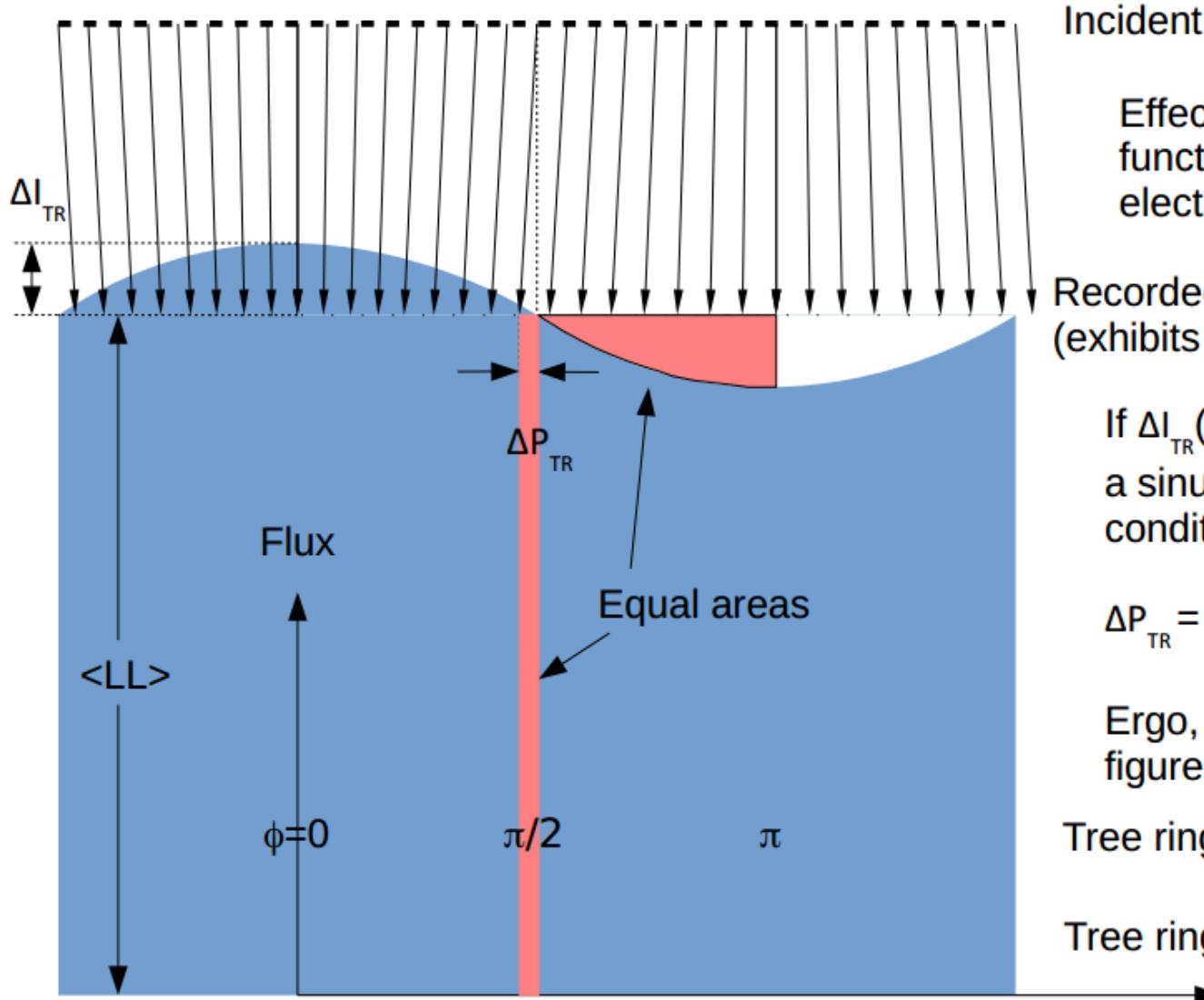
- Initial tree ring implementation in Phosim had a flaw which caused the lateral electric field (and thus the shift) to grow linearly with tree ring period.

Tree Rings in Flats

- Switching to more robust analysis method.
- Number of electrons collected/pixel clearly trace tree rings.
- Verify that Phosim accurately produces corresponding astrometric shift variations and flat field intensity variations.



Fundamental relationships between flat field response and astrometric shifts (for a sinusoidal case)



Incident flux distribution is constant

Effective mapping
function imparted by
electrostatic drift lines

Recorded flux distribution
(exhibits tree rings)

If $\Delta I_{TR}(x)$ is well characterized by
a sinusoid (and it is), continuity
condition requires that

$$\Delta P_{TR} = \text{period}/(2\pi) * \Delta I_{TR} / <LL>$$

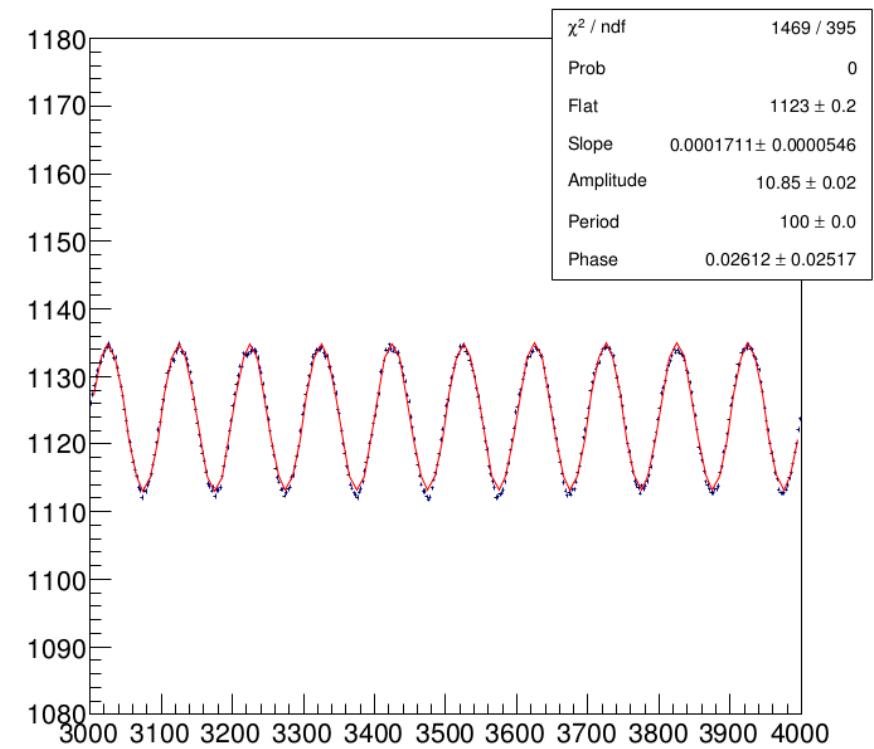
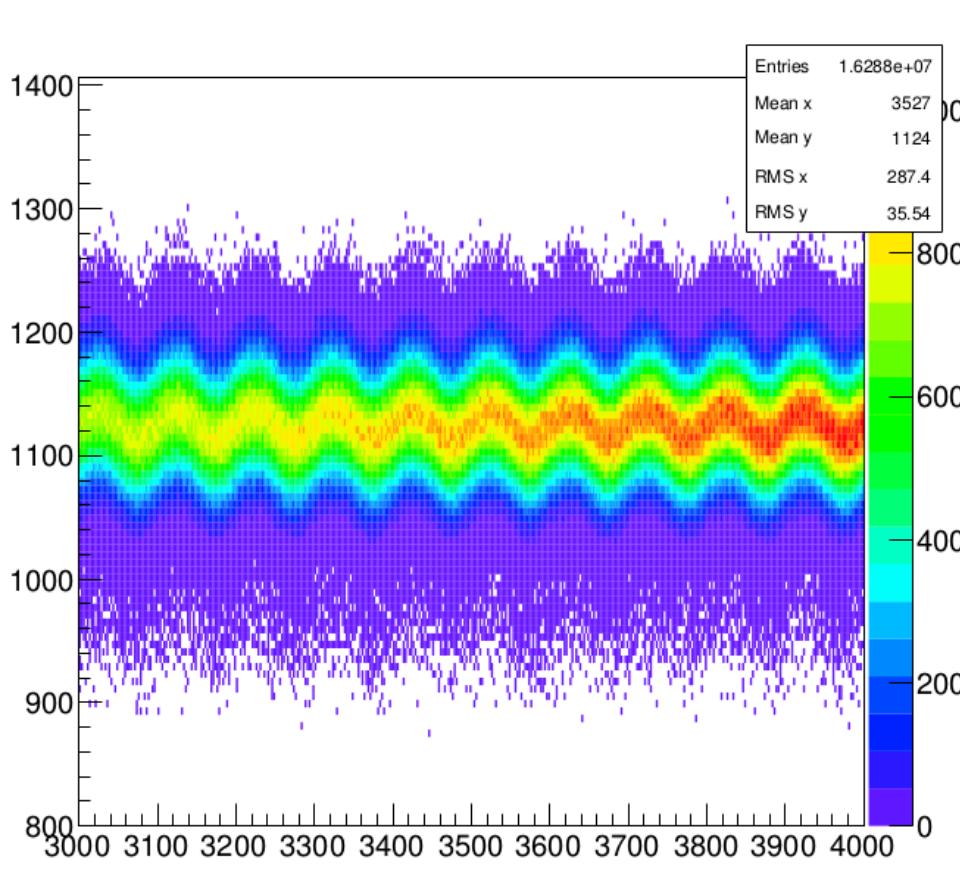
Ergo, aspect ratio of Lissajous
figure **must be** period/(2 π)

Tree ring phase [rad]

Tree ring radial coord [pix]

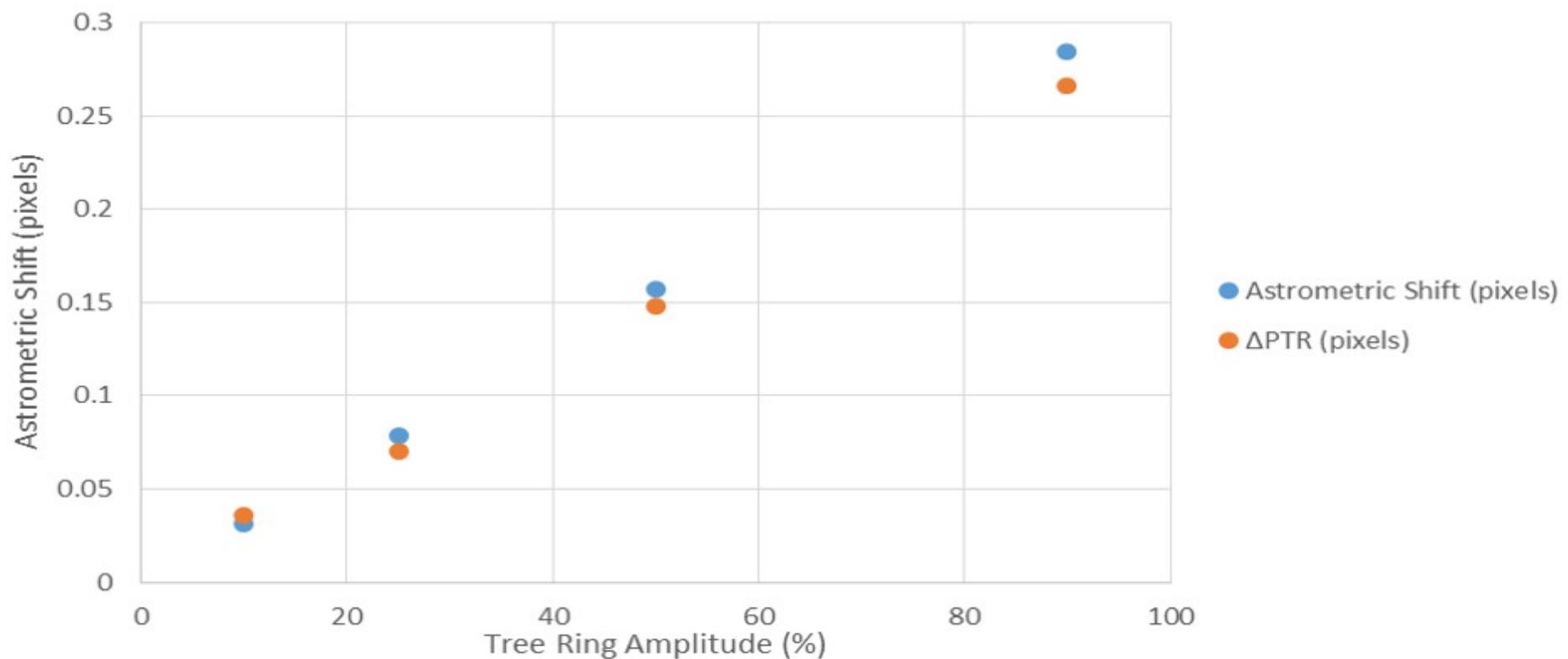
TR fits in VM/Root

- 420 nm flat with 50% doping variation
- June 2014 Phosim version



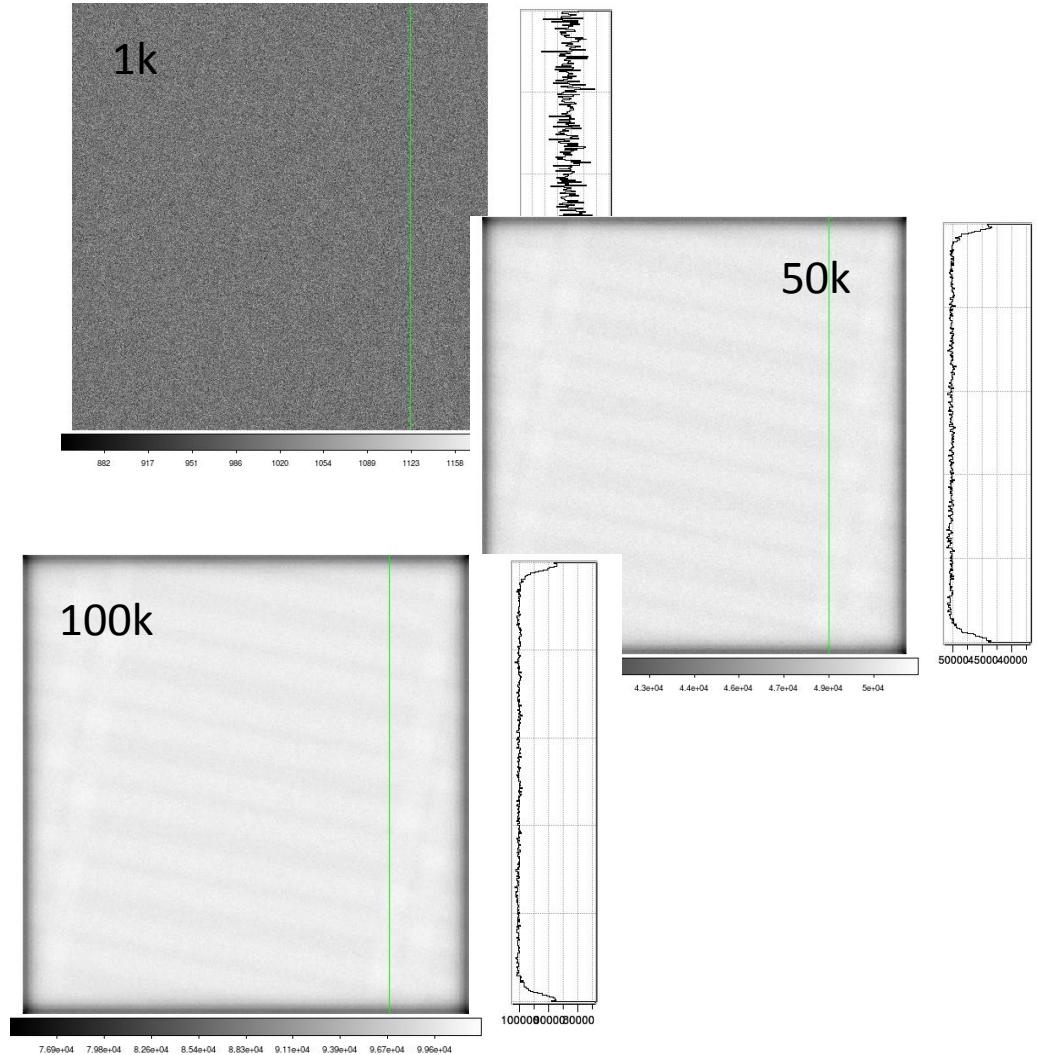
Comparison

TR shift vs TR amplitude



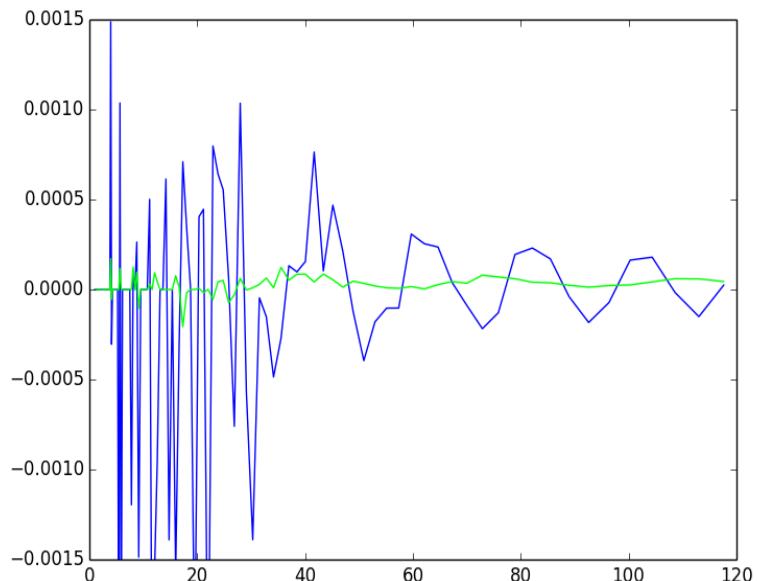
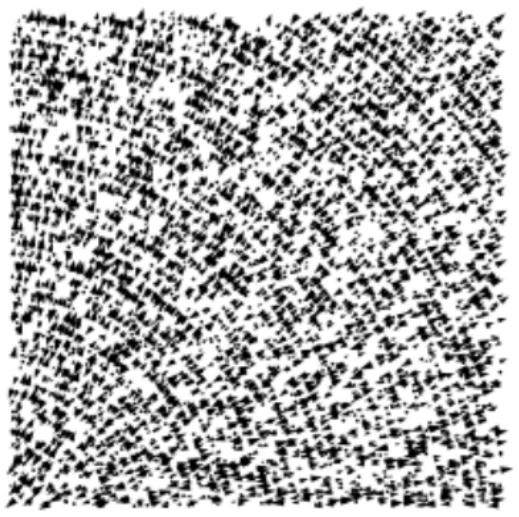
Edge Effect Flats

- Ongoing exploration of edge effect.
- Not clear if edge rolloff properly implemented as of yet.

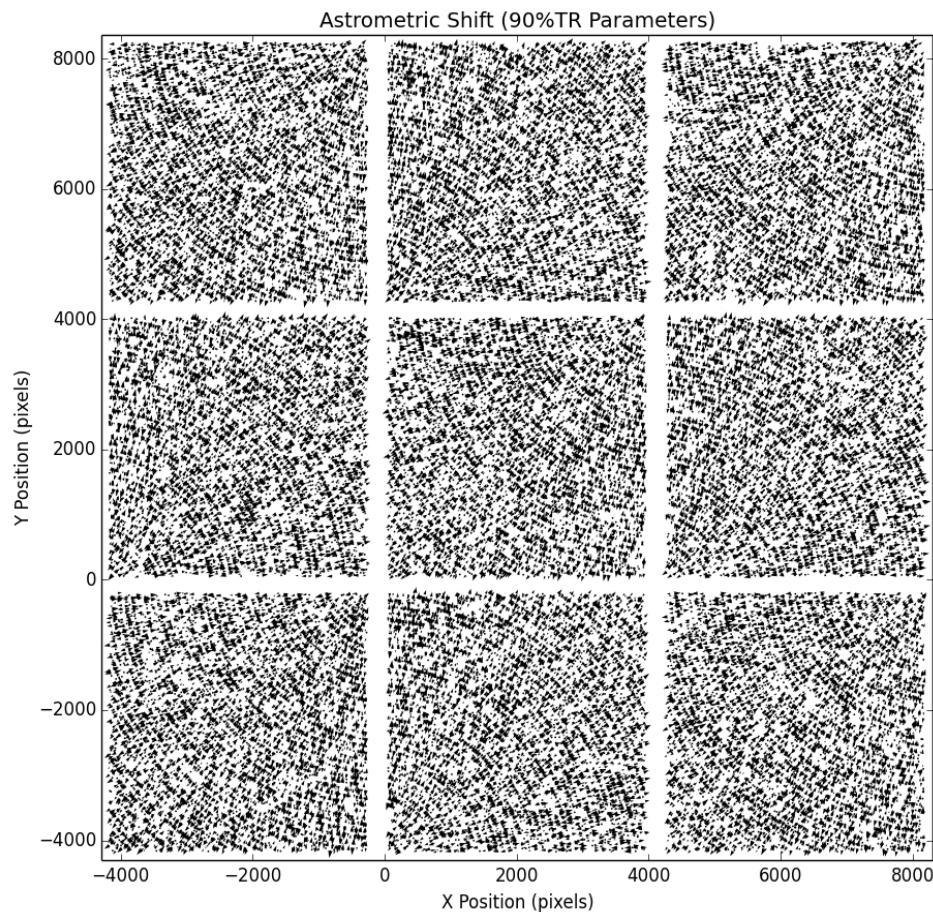
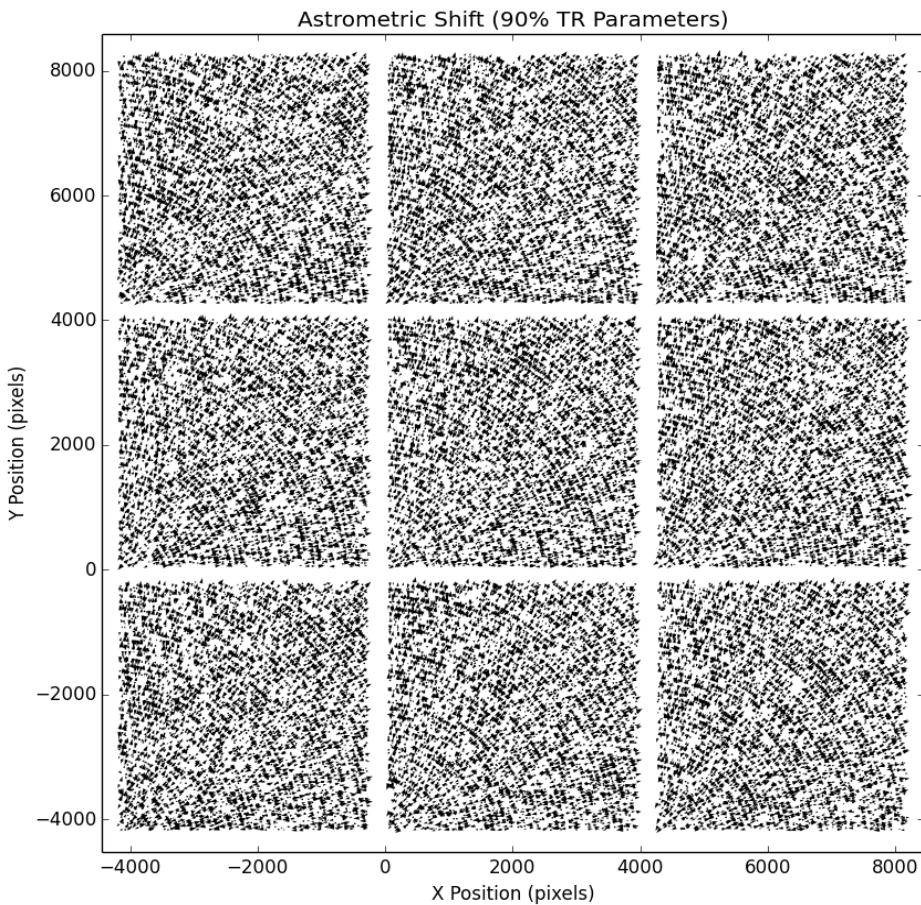


Tree Ring Ellipticity Correlations

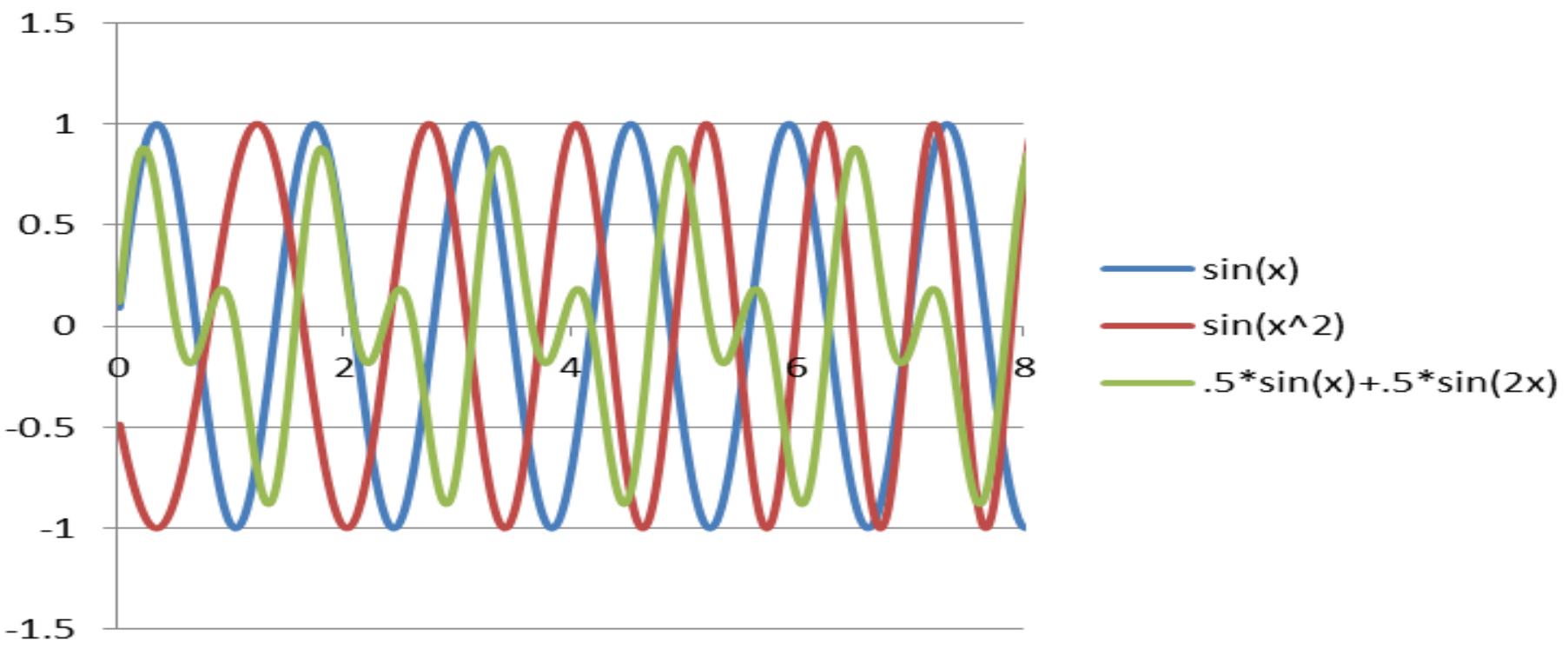
- Within chip, short range correlations appear as expected.
- Degree of correlation varies with tree ring origin position.



Possible Raft-level Correlations



More complex models for TR period



- Current Phosim model for tree rings clearly oversimplified
- Ongoing investigation of whether superpositions of sines with differing phases and amplitudes or sines with changing frequency better matches real data

Plans

- Conclude raft-level ellipticity correlation investigation
- Recommend more nuanced TR model for Phosim
- Write up of Phosim tree ring investigation